Probe and system for extracting gases from a process environment

The present invention relates in general to systems for the regulation and control of chemical processes which involve the production of gas, for example processes of combustion in cement furnaces.

Systems are known for the extraction of gases from a furnace, provided with probes to be mounted within the furnace, in which the gases extracted are conveyed to analyser devices.

For the extraction of the gases such systems utilise a small pump of low power and low pressure, in suction (through the probe). This implies treating the gases hot/moist, giving rise to corrosive acids which attack the couplings, the tubes and the various components involved in the flow of gas, aggravating the situation. For the purpose of avoiding the precipitation of condensate in the system (because it draws in hot/moist gas), it is necessary to heat the aspiration tube, the filter and the tube but with declining results (problems of packing, acids etc).

The probes further have serious problems of blockage of the gas aspiration tube, which make operation unreliable.

Moreover, in traditional probes the filtering of dust is achieved solely by the filter which is overloaded and becomes clogged. The cleaning of the probe is achieved by a washing cycle with compressed air (programmable) but often it is insufficient fully to restore it and, moreover, this introduces contamination into the gas to be analysed.

Because of these problems the values of the furnace gas analysis are approximate and irregular, leading to a misunderstanding of a correct management of the line, especially in the presence of alternative fuels. With these latter, even the best probes currently in commercial use show their limits. Only by meticulous and continuous surveillance and maintenance by man is it possible to obtain results, which even then are only just sufficient.

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One object of the invention is that of providing a ~~probe~~ system for ~~the extraction of gases~~ extracting a gaseous fluid to be analysed from a process environment which is able to prevent or at least reduce the occurrence of clogging of the probe, that is to say to guarantee continuity of use without continual maintenance interventions, (with improvements in the gas extraction system and reliability of the analysis) continuity and.

This object is achieved according to the invention by a ~~probe~~ system for extracting ~~of gases~~ a gaseous fluid to be analysed from a process environment having the characteristics defined in Claim 1.

Preferred embodiments for the probe are defined in the dependent claims.

Another object of the invention is ~~that of providing~~ a ~~system~~ method for ~~the extraction of gases~~ extracting and re-injecting a gaseous fluid from a process environment, and to ~~which~~ having ~~reduces in the most complete manner the ingress of dust and condensate through the probe, as well as guaranteeing continuity and reliability of the analysis~~ the characteristics defined in Claim 12.

~~This object is achieved according to the invention by a~~ system for extracting ~~gases from~~ a process environment, ~~having the characteristics defined in Claim 11~~.

GB-A-1 445 061, US-A-4 336 722, DE 44 30 378 A1, CA-A1-2 196 846 and US-A-3 938 390 disclose systems for extracting a gaseous fluid to be analysed from a process environment.

In particular, GB-A-1 445 061 discloses a system for extracting a gaseous fluid to be analyzed from a process environment, comprising:

- a probe for extracting said gaseous fluid, comprising a first tubular element, which can be positioned within the interior of the process environment, the said first tubular element having at one end a gas aspiration opening and defining an internal cavity, and a second tubular element extending within the cavity of the first tubular element, the said second tubular element being operable to inject the said gaseous fluid into the interior of the cavity towards the said aspiration opening of the first tubular element and from there again into the process environment,
- aspiration means for aspirating the gaseous fluid from the process environment through the cavity of the said first tubular element of the probe,
- take-off means connected to the said aspiration means for taking-off a fraction of the said gaseous fluid, the said take-off means being further connected to analyzer means for analysis of the said gaseous fluid, and
- re-injection means for re-injecting the said gaseous fluid into the process environment through the second tubular element.

The system of GB-A-1 445 061 solves the problem of preventing the clogging of the probe only in a limited way.

Preferred embodiments of the system are defined in the dependant claims.

This system, by co-operating with the probe according to the invention, lowers the dust (filter less stressed), makes it possible to dry the gas (no clogging and no origination of acids) and is self cleaning without the aid of compressed air but by utilising the same process gas (continuity of analysis since it is not altered).

Its use makes it possible to extract combustion gases from a furnace so that they can be analysed by means of classical analysers. It makes it possible to obtain reliable analysis of the combustion gases of the furnaces. Consequently, there is the possibility of optimising the control of the installation (reducing fuel consumption and improving the quality/quantity of the furnace product) and of monitoring/reducing atmospheric emissions.

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It is applicable to any type of furnace (in any conditions of use; temperature, dust level, steam, acid etc) with any type of fuel (even alternative/waste disposal fuel) and any type of process material.

The probe has been designed for cement furnaces but can be used in process environments in industries of different type; steelworks, thermo-electric plants, chemical/petrochemical industries, carbon grinding and storage, incinerators, explosive powder storage silos, that is to say in all those sectors where it is required to extract gas for subsequent analysis (furnaces, silos, chimneys, pipework etc).

The salient characteristic of the probe and the system according to the invention is the reduced necessity for maintenance. This is achieved by avoiding aspiration of dust/condensate, and thanks to the violent and continuous spraying of compressed gas ensured by the compressor.

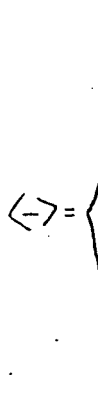
The filter has a long life since it is self-cleaning by means of the powerful counter current flow of gas during the rapid discharge for probe cleaning.

Moreover a reduction of dry dust is achieved by using the compressed gas from the furnace and without a water spray. There is moreover a drying of the gas with consequent reduction of acids. The system is self-cleaning with a continuous cycle, again by the effect of the compressed gas, and therefore does not require the washing cycle with compressed air which would falsify the gas analysis (by polluting it) but by using the gas from the furnace. This avoids having to use a large number of control panels for the treatment of the gas (with filters, antacids, bubbling chambers etc), control panels for solenoid valves and various dedicated electrical control panels (with PLC). This leads to a reduction of the associated problems and costs.

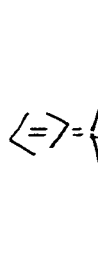
<=> from page 5

For use at high temperatures the probe is water-cooled. It has an anti-condensate interspace for decoupling the hot zone (gas circuit) from the cold zone (cooling water jacket), permitting the gas extracted to maintain its temperature. This arrangement avoids the formation of condensate in the inner wall of the aspiration tube, thereby minimising clogging of the dust. The two chambers for gas and cooling can be separated because they are coupled with flanges. This makes is possible to remove only the gas circuit from the

furnace (for a possible inspection and cleaning, even with the furnace in operation) leaving only the cooling system fixed to the furnace.



The reliability and continuity of the system makes it possible to utilise its output for automatic furnace management (not having compressed air washing which gives rise to O2 peaks). The capacity of the compressor is high, therefore the response is faster than in usual systems, and possible micro-losses have no influence. Consequently a more reliable analysis is achieved.



The probe is easy to install in a short time, not requiring a great deal of work for adaptation of the existing system to be able to connect it. Moreover, it does not require a great deal of care in research for the optimum positioning in the furnace (the minimum dust point etc).

A preferred but non-limitative example of the invention will now be described making reference to the attached drawings, in which;

- Figure 1 is a general diagram of a system for the extraction of burnt gases from a furnace according to the invention;
- Figure 2 is a schematic side view of a probe for extraction of burnt gases from a furnace, according to the invention;
- Figure 3 is a schematic side view of a probe of Figure 2 without the cooling jacket; and
- Figure 4 is a schematic side view of the cooling jacket of the probe of Figure 2.

aspiration tube 2 (second tube) and makes it possible for the gas withdrawn not to be excessively cooled. The gas is aspirated into the chamber CA constituted by the first and second tube 1, 2 and injected again into the interior of the furnace through of the concentric central tube (first tube 1), by means of a compressor C. The furnace side end UG of the central tube is throttled so that the ejected gas is compressed. Preferably, this end has a nozzle. Alternatively, the same central tube 1 can be ~~designed to~~ realised as a capillary tube for injecting the gas towards the probe head TS ~~(for example it can be formed as a capillary tube)~~. In this way the gas acquires a certain pressure and kinetic energy, constituting a barrier against dust and effecting cleaning of the probe head TS. In substance the gas is aspirated through the piping 40 and returned to the furnace with an adequate pressure and velocity through the piping 50, by means of the compressor C. In the gas aspiration and delivery circuit 40, 50 (furnace - compressor C - furnace) there is fitted a branch 41 which delivers a small percentage of fluid to be analysed to traditional analysers ~~O2 CO NOX~~ AG by means of a pump PM with a take off upstream of the compressor C. Upstream of the analysers are disposed a regulator RF for the flow of gas to the analysers and a sensor P2g for control of the pressure of the gas to the analysers. These analysers are moreover protected by a filter F3G, which acts as an anti-acid/condensate. Downstream of the analysers is disposed a gas discharge SG exiting from the analysers.

Before reaching the compressor C and the pump PM the gas is suitably filtered by upstream filters F1G and F2G in the aspiration piping 40. The filter F1G is connected to a dust decanter D to reduce the possible dust present in the circuit. The high flow rate of the circulating fluid

guarantees short response times which benefit the management of the furnace.)

A sensor P1g for control of the gas pressure of the compressor and a valve VSG for gas overpressure of the compressor C are connected to the delivery of the compressor C.

There are also two reservoirs S1G (depressurized) and S2G (pressurized) in the system, on the aspiration and delivery sides of the compressor C respectively. These perform the function of collecting the condensate and stabilising the pressure/depression of the compressor. In particular, the reservoir S2G forms part of a refrigerator/dryer RE for reducing the condensate. Downstream of the reservoir S2G is connected an automatic condensate discharge valve VAC arranged to discharge the condensate SC. The reservoirs are also furnished with two timing solenoid valves EV1G and EV2G activating the respective servo-valves in a cyclic manner for times which can be set, depending on the requirements. The solenoid valve EV1G is a two-way valve mounted between the depressurized reservoir S1G and the aspiration of the probe S, and has the function of stopping the aspiration from the probe S so that the thrust of its delivery is reinforced to improve the cleaning of the probe head. Downstream of the solenoid valve EV1G is disposed a sensor Fg for control of the flow of gas to the compressor C. The three-way solenoid valve EV2G mounted upstream of the preceding one, has the function of violently discharging, with a full jet, the quantity of fluid in the pressure reservoir S2G, towards the aspiration tube 2. This enormous quantity of fluid flows at high velocity in the opposite direction from the normal flow, sweeping towards the furnace interior any possible deposits

furnace, avoiding transporting them along the analysis installation. This is of benefit to the tubing, the connectors, the compressor, the pump, the analysers, and the control and security sensors, and will result in a greater efficiency and duration of these. Moreover it is possible to make these of more economic commercial type and it is not necessary for them to be of the more expensive anti-acid type. The probe and the system according to the invention reduce dust (less stressed filter), dry the gas (no accretion and no origination of acids) and the probe is self-cleaning without the aid of compressed air but by utilising the same process gas (continuity of analysis since it is not altered).

In other words, ⟨≡⟩

The strong point of this probe is the compressor central-tube which permits the gas to re-circulate to the furnace with a certain pressure and kinetic energy. Naturally, in place of the compressor it is possible to utilise another type of continuous cycle machine.

⟨≡⟩ = With the compressor and the branching principle one obtains: dust-free and dried gas (by the barrier effect) and self-cleaning head without the necessity for the compressed air washing cycle (by means of a continuous cycle without interruption and alteration of the analysis gas).

CLAIMS

1. A system for extracting a gaseous fluid to be analysed from a process environment, comprising

a probe (S) for extracting said gaseous fluid, comprising a first tubular element (2), which can be positioned within the interior of the process environment, the said first tubular element having at one end a gas aspiration opening (TS) and defining an internal cavity (CA), and a second tubular element (1) extending within the cavity (CA) of the first tubular element (2), the said second tubular element being operable to inject the said gaseous fluid into the interior of the cavity (CA) towards the said aspiration opening of the first tubular element (2) and from there again into the process environment,

aspiration means (40, C) for aspirating the gaseous fluid from the process environment through the cavity (CA) of the said first tubular element (2) of the probe (S),

take off means (41, PM) connected to the said aspiration means (40, C) for taking off a fraction of the said gaseous fluid, the said take off means being further connected to analyser means (AG) for analysis of the said gaseous fluid, and

re-injection means (50, C) for re-injecting the said gaseous fluid into the process environment through the second tubular element (1),

characterised in that the said aspiration means (40, C) and the said re-injection means (50, C) share compressor means (C), said compressor means having an aspiration side and a delivery side, wherein the said first tubular element is fluidly connected to control valve means (EV2G) operable to fluidly connect said first tubular element selectively

with one of the said aspiration side and said delivery side of the compressor means, and

in that the said second tubular element is disposed in fluid communication with the delivery side of said compressor means through a reservoir (S2G), the said second tubular element being throttled in such a way to accelerate the said gaseous fluid flowing through it and, at the same time, to allow an accumulation of the said gaseous fluid upstream within the said reservoir,

in such a way that the system can assume an aspiration condition, wherein the gaseous fluid is aspirated through the said first tubular element and is partially re-injected through the said second tubular element and partially accumulated by the said reservoir, and a back washing condition, wherein the gaseous fluid is released by the said reservoir through the said first tubular element by means of activation of the said control valve means (EV2G).

~~CLAIMS~~

~~1. A probe (S) for extracting gases from a process~~ environment comprising a tubular element (2), which can be positioned within the interior of the process environment, the said tubular element having at one end a gas aspiration opening (TS) and defining an internal cavity (CA) by which the said process environment can be put into fluid communication with a gas take off system, characterised in that it further includes injection means (1) coupled to the first tubular element (2), operable to inject the said gaseous fluid into the interior of the cavity (CA) accelerated towards the said aspiration opening of the first tubular element (2) and from there again into the process environment.

2. A probe according to Claim 1, in which the said injection means comprise a second tubular element (1) extending within the cavity (CA) of the first tubular element (2), formed in such a way as to be able to inject the said accelerated gaseous fluid towards the said aspiration opening of the first tubular element (2) and from there again to the process ~~environment~~.

2 system 1
3. A ~~probe~~ according to Claim 2, in which the end of the second tubular element (1) disposed on the side of the aspiration opening, that is to say the process environment side, is provided with a nozzle (UG).

3 system
4. A ~~probe~~ according to Claim 1 or 2, in which the said first (2) and second (1) tubular element are coaxial.

4 system 3
~~5~~. A ~~probe~~ according to Claim ~~4~~, including connector elements (CR,T), pierced nuts (DT) and gas tight seals operable to assemble the said first (2) and second (1) tubular element and to render the second tubular element (1) slidable with respect to the first tubular element (2).

5 system
~~6~~. A ~~probe~~ according to any preceding claim, further including a cooling jacket (CRA) disposed around the said first tubular element (2).

6 system 5
~~7~~. A ~~probe~~ according to Claim ~~6~~, in which the said cooling jacket is disposed in such a way as to define an inter space (IN) interposed between the said jacket and the first said tubular element (2).

7 system 5 6
~~8~~. A ~~probe~~ according to Claim ~~6~~ or ~~7~~, in which the said cooling jacket is assembled in a separable manner from the said first tubular element (2) of the probe (S).

8 system 5 7
~~9~~. A ~~probe~~ according to any of Claims from ~~6~~ to ~~8~~, in which the said cooling jacket is connected in fluid communication with a low temperature refrigerator with a closed fluid circuit.

9 system
~~10~~. A ~~probe~~ according to any preceding claim, further including a shielding element (CP) disposed in proximity to the said aspiration opening (TS).

~~11. A system for extracting gases from a process~~ environment, which can be coupled to a ~~probe~~ according to any preceding claim, comprising ~~means~~ (40, C) for aspirating the gas from the ~~process~~ environment through the said first ~~tubular element (2) of the probe (S), characterised in that~~

~~it further includes means (50, C) for re-injecting the said~~ gas into the probe/process environment, disposed in fluid communication with the said injection means (1) of the probe (S).

12. The system according to Claim 11, in which the said means for aspirating the gas (40, C) and the said means for re-injecting the gas (50, C) comprise a common continuous cycle machine (C) operable to aspirate, compress and inject the said gas back into the same process environment, that is to say to confer pressure and kinetic energy on the gas.

13. A system according to Claim 12, further including a reservoir (S2G) disposed in the delivery of the said continuous cycle machine (C) for stabilising the pressure in the said injection means (1) of the probe (S) and for obtaining a rapid discharge of the gas cyclically for counter-current cleaning of the said first tubular element (2) of the probe (S), that is to say to effect back washing.

14. A system according to Claims 11 to 13, further including control means (EV1G, EV2G), operatively connected to the said means for aspirating the gas (40, C) and the said means for re-injecting the gas (50, C) for effecting probe cleaning cyclically, and continuously with the same process gas.

15. A system according to any of Claims 11 to 14, further including take off means (41, PM) connected to the said aspiration means (40, C) for taking off a fraction of the said gas, the said take off means being further connected to ~~analyser means (O2-CO-NOX) for analysis of the said gas~~.

10 preceding
~~16~~. A system according to any ~~of~~ Claims ~~11 to 15~~, further including decanter means (D) and drying means (RE) disposed downstream of the probe (S) in such a way as further to reduce the dust and the condensate in the said gas.

11 preceding
~~17~~. A system according to any ~~of~~ Claims ~~11 to 16~~, further including a vacuometer (Vg) connected to the first tubular element (2) of the probe (S) and a manometer (Mg) connected to the ~~injection means~~ second tubular element (1) of the probe (S) for monitoring the operation conditions of the probe.

12. A method for extracting and re-injecting a gaseous fluid to be analysed from and to a process environment, the said method using

a probe (S) for extracting said gaseous fluid, comprising a first tubular element (2), which can be positioned within the interior of the process environment, the said first tubular element having at one end a gas aspiration opening (TS) and defining an internal cavity (CA), and a second tubular element (1) extending within the cavity (CA) of the first tubular element (2), the said second tubular element being operable to inject the said gaseous fluid into the interior of the cavity (CA) towards the said aspiration opening of the first tubular element (2) and from there again into the process environment,

wherein the method comprise the following step:

aspirating the gaseous fluid from the process environment through the cavity (CA) of the said first tubular element (2) of the probe (S),

taking off a fraction of the said gaseous fluid for analysing it,

re-injecting the said gaseous fluid into the process environment through the said second tubular element (1) of the probe (S),

characterised in that the said gaseous fluid is only partially re-injected into the process environment, a portion of the gaseous fluid being accumulated apart, and

in that the method comprise a back washing step, wherein the accumulated gaseous fluid is released into the process environment through the said first tubular element.

13. A method according to claim 12, wherein the said back washing step is performed cyclically.

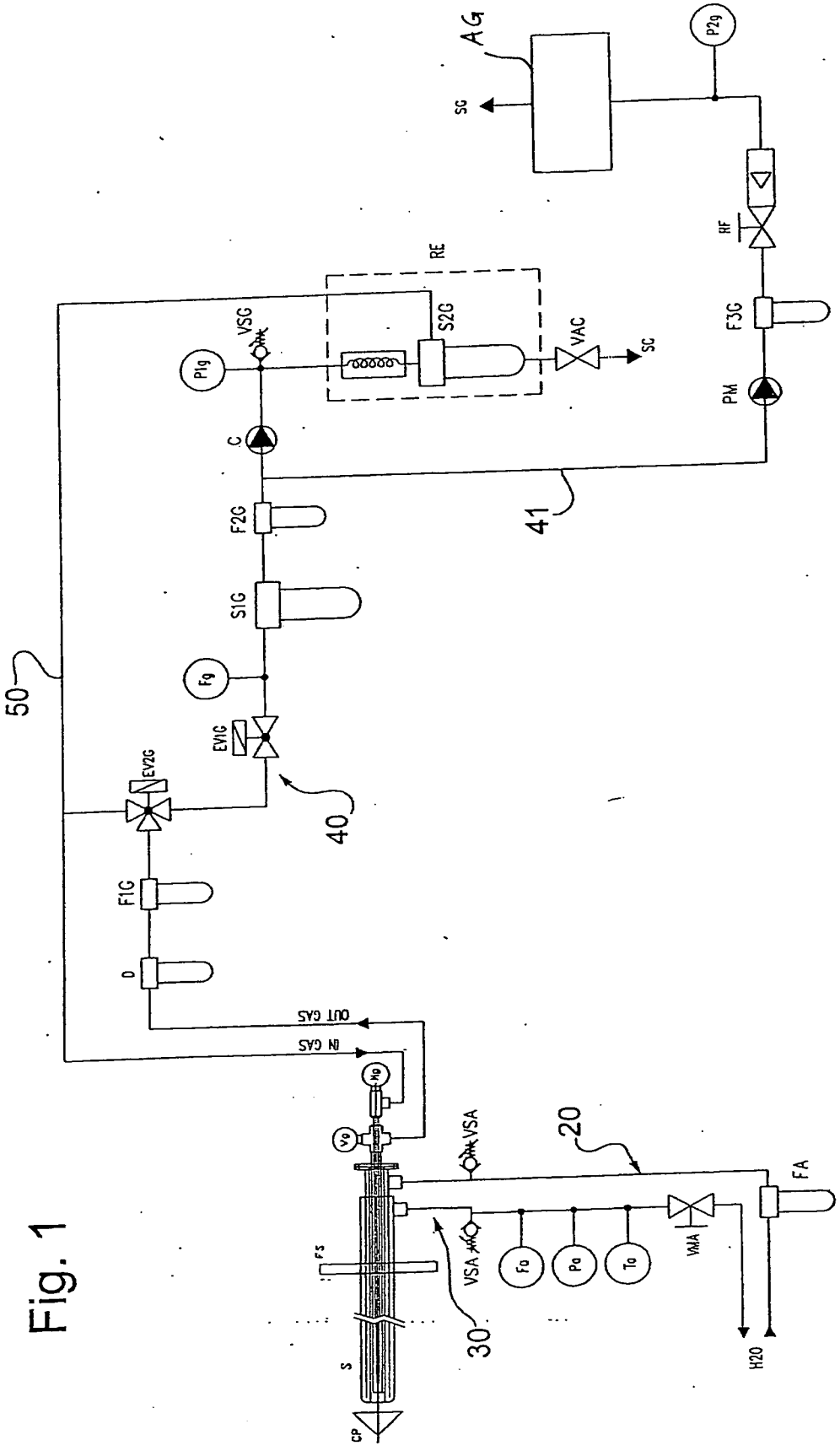

AG
SG
P2g
RF
F3G
PM
RE
S2G
VAC
SC
VSG
P1g
C
F2G
S1G
Fg
EV1G
EV2G
F1G
D
50
40
41
OUT GAS
IN GAS
Ng
Vg
VSA
20
FA
VMA
H20
Fa
Pa
Ta
VSA
30
Fs
S
CP

Fig. 1

INTERNATIONAL SEARCH REPORT

PCT/IB2005/051145

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01N1/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1 445 061 A (BECKMAN INSTRUMENTS INC) 4 August 1976 (1976-08-04) page 2, line 11 - line 39 figures 1,3,4	1-17
X	US 4 336 722 A (SCHWEITZER ET AL) 29 June 1982 (1982-06-29) column 3, line 45 - line 65 column 4, line 49 - column 5, line 23 figure 1	1,11
X	DE 44 30 378 A1 (ERWIN SICK GMBH OPTIK-ELEKTRONIK, 79183 WALDKIRCH, DE) 29 February 1996 (1996-02-29) column 3, line 30 - line 52 figure 1	1,11

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 July 2005	29/07/2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Timonen, T

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INTERNATIONAL SEARCH REPORT

PCT/IB2005/051145

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CA 2 196 846 A1 (GOODFELLOW TECHNOLOGIES INC) 5 August 1998 (1998-08-05) figures 1-7	1-17
A	US 3 938 390 A (GREY ET AL) 17 February 1976 (1976-02-17) figure 2	1-17
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